

2 A student investigates the relationship between the luminosity of a star and its mass.

The student obtains data of relative luminosity  $\lambda$  and relative mass  $\mu$  for six stars, where

$$\lambda = \frac{\text{luminosity of star}}{\text{luminosity of Sun}}$$

and

$$\mu = \frac{\text{mass of star}}{\text{mass of Sun}}$$

It is suggested that  $\lambda$  and  $\mu$  are related by the equation

$$\lambda = k\mu^n$$

where  $k$  and  $n$  are constants.

(a) A graph is plotted of  $\lg \lambda$  on the  $y$ -axis against  $\lg \mu$  on the  $x$ -axis.

Determine expressions for the gradient and  $y$ -intercept.

gradient = .....

$y$ -intercept = .....

[1]

(b) Values of  $\mu$  and  $\lambda$  are given in Table 2.1.

**Table 2.1**

$\mu$	$\lambda$	$\lg \mu$	$\lg \lambda$
$4.6 \pm 0.4$	500		
$5.4 \pm 0.4$	800		
$8.4 \pm 0.4$	3200		
$11 \pm 1$	7000		
$16 \pm 1$	25000		
$18 \pm 1$	38000		

Calculate and record values of  $\lg \mu$  and  $\lg \lambda$  in Table 2.1.

Include the absolute uncertainties in  $\lg \mu$ .

[2]

(c) (i) Plot a graph of  $\lg \lambda$  against  $\lg \mu$ .

Include error bars for  $\lg \mu$ .

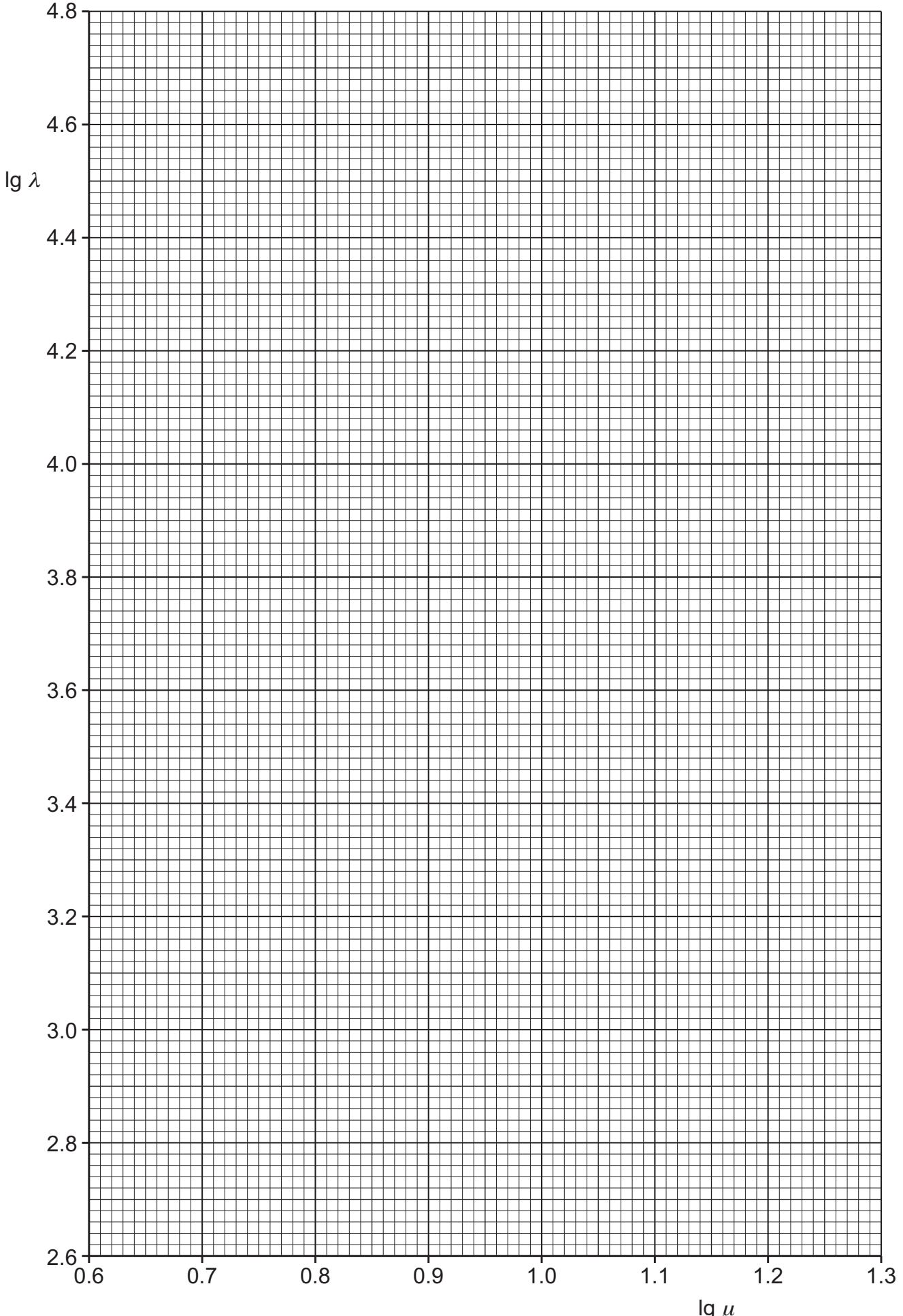
[2]

(ii) Draw the straight line of best fit and a worst acceptable straight line on your graph. Label both lines.

[2]

(iii) Determine the gradient of the line of best fit. Include the absolute uncertainty in your answer.

gradient = ..... [2]



(iv) Determine the  $y$ -intercept of the line of best fit. Include the absolute uncertainty in your answer.

$y$ -intercept = ..... [2]

(d) Using your answers to (a), (c)(iii) and (c)(iv), determine the values of  $k$  and  $n$ . Include the absolute uncertainties in your values. You need not be concerned with units.

$k$  = .....

$n$  = .....

[3]

(e) The mass of the Sun is  $2.0 \times 10^{30}$  kg. The star Alpha Centauri B has a value of  $\lambda$  of 0.46.

Determine the mass  $M$  of Alpha Centauri B.

$M$  = ..... kg [1]

[Total: 15]